The Transducer Function: An Introduction to a Theoretical Typology in Electronic Literature and Digital Art

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ABSTRACT

In this essay I introduce the notion of a transducer function in the fields of electronic literature and digital art. Firstly, I survey the transduction concept throughout its history in such domains as physics, genetics, microbiology, biochemistry, physiology, psychology, philosophy, logic and computer science. Secondly, I discuss the relevance of a transduction theory versus the advantage of a transducer function. I migrate the transduction concept into the fields of electronic literature and digital art, showcasing the contexts of application, and several transfer processes and functions. Finally, I apply the transducer function as a theoretical typology and a recognizable system, highlighting artwork by R. Luke DuBois, André Sier and Scott Rettberg that can be read within this framework. Thus, it means taking into account a set of transfer and conversion processes: information, patterns and data among mechanisms, technologies, themes, and creative and theoretical guidelines. In this sense, I develop a critical framework that operates as a method for analyzing and comprehending further digital artwork.

Keywords: *Transduction; Transducer Function; Electronic Literature; Digital Art; Zeitgeber; Data Mining and Visualization; Digital Installation; Net.Art; Digital Kinetic Poetry*

1 | INTRODUCTION: THE CONCEPT OF TRANSDUCTION

The transduction theory is based on an analogy derived from the concept of transducer. The transducer is a device or element (concept of physics) that transforms one type of energy into another, e.g., wind energy into electrical energy or electrical energy into acoustic energy. The transducer acts between both electrical physical quantities and non-electrical physical quantities, such as sound or light, symbolizing a mediator and a converter. Since the 1940s, the concept of transduction has been applied to physics, genetics, microbiology, biochemistry, physiology, psychology, philosophy, logic and computer science. In the field of physics, as I said, transduction is a process which comprises the transfer and conversion of one type of energy or physical quantity into another. This property depends on measurement and conversion tools known as transducers. The transducer is thus:
A device that converts one form of energy into another form of energy. In most cases, it consists of converting electrical energy into a mechanical displacement or converting a non-electrical physical quantity such as sound, temperature, pressure, velocity, or light, into electrical quantity. With the use of electronic instrumentation, transducers can be used to measure, modify and improve the current state of technology in industrial

applications. [...] Today, transducers are also widely used in telemetry (transmission of quantified data at distance). (Lavareda & Martins, 2004)

Thereby, the definition by Lavareda and Martins follows the statement by Robert G. Seippel (1988). We may find examples of these energy conversions in devices such as, for example, antennas, dynamos, batteries, electric sensors, electric motors, light generators, heating pumps, photodiodes, microphones, thermometers, transistors, watermills, windmills and, of course, wind generators, as well as ultrasonic transducers and digital transducers. This diversity of transducers also occurs in the diversity of approaches and applications of the concept of transduction.

In the fields of genetics and microbiology, following the theories by Joshua Lederberg and Norton Zinder, generalized transduction is a phenomenon which consists in transferring genetic material (a DNA segment) from one cell to another, for example, in the case of a virus, phage or bacteriophage that carries transducer particles from a host cell into a recipient cell. The primary bacteria identified in the paper by Lederberg and Zinder (1952), *Salmonella typhimurium*, has led the authors to formulate a new term: 'The mechanism of genetic exchange found in these experiments differs from sexual recombination in *E. coli* in many respects so as to warrant a new descriptive term, transduction.' (679). Similarly, in biochemistry, the signal transduction is based on the transfer and conversion of a signal from one cell to another, having been introduced by Ludger Rensing (1972) and continued to be applied by several authors, such as Ogata, Matsunaga, and Sato (1990). In physiology, it corresponds to the transformation of a stimulus into another, with different forms.

In the field of psychology, Jean Piaget (1945) introduced the concept of transduction in the cognitive representation of children. During childhood, the child tends to reason by using an inference method that transfers the characteristics of the individual to the collective, from the part to the whole, generalizing from the examples of a particular case. According to Piaget, this phenomenon of transduction is similar to the imagery that one witnesses during a dream. In the field of philosophy, Gilbert Simondon (1989) defined transduction as the operating process, which transfers a physical, biological, mental or social activity, from one location to another, framing it in his broader theory of individuation.

In the field of logic and computer science (machine learning), Vladimir Vapnik (1995) inserted the concept of transduction, having been developing research with transducer algorithms. According to Gammerman, Vovk, and Vapnik (1998, p. 5), transduction means 'inference from particular to particular'.

Accepting this constant of transfer and conversion that embodies the concept and theory of transduction as default to all disciplines, we may then migrate it into the fields of literature and art.

2 | TRANSDUCTION THEORY OR TRANSDUCER FUNCTION?

As we have seen, the transducer technically and symbolically assumes itself as a mediator and a converter. In this sense, rather than make a general theory in the scope of literature and art, it is important to note that one finds transduction in digital artworks as an aesthetic and formal process, or as a technical process, i.e. as a function. In this section, I analyze the reasons that led me to the composition of the *transducer function*.

2.1 APPLICATION CONTEXTS

Any theoretical domain, as Katherine Hayles (2008) points out, when importing a concept, tends to perform a transforming operation, removing and adding new meanings. Considering this transition, when applied to the research on electronic literature and digital art, transduction gains a metaphorical character, if one considers a thematic macro setting, and a pragmatic character, if one considers the formal and functional micro setting of specific artworks.

In recent years, there have been several theoretical models that tried to systematize a field of research. The works of Joyce (1995), Aarseth (1997), Kittler (1999), Manovich (2001), Zielinski (2006), Galloway (2006), Hansen (2006), Jana & Tribe (2006), Paul (2008) and Hayles (2008) have all attempted to establish a set of features and critical viewpoints, respectively, in hyperfiction, cybertextuality, media, new media, media archeology, game studies, new media philosophy, new media art, digital art and electronic literature. Although all these models are useful, their scope tends to be universal, defining each field in their specificity. However, since the purpose of this essay is not to confront and explain each of these models, neither to exploit the flaws or the unclassifiable cases, I can say that its aim is rather to diagnose similar processes and mechanisms in many works of electronic literature and digital art.

2.2 TRANSFER PROCESSES AND FUNCTIONS

In order to investigate and register these transfer and conversion processes I applied a migration of valences from other areas based on the characteristics of transduction presented in the previous section. If I had built a universal theory of transduction, I would inevitably conclude its failure, as it occurs, for instance, in the theory of intermediation by Hayles (2008), or the theory of embodiment by Hansen (2006). Therefore, I elaborated the *transducer function*, which, absorbing the features mentioned, does not aspire to constitute itself as the only possibility in the wider spectrum of theories in the context of digital culture and technologies. Its aim is to become a typology, a constellation of observable processes that are recurring. In this sense, this typology underpins itself through different transfer processes and functions:

a) The *zeitgeber* function. In the set of nonlinear dynamic systems, one finds the oscillatory one such as biological clocks. Within this field of chronobiology, there are circadian clocks, i.e. the biological rhythms with the length of a day (24 hours), which bisect and create a distinction between endogenous and exogenous rhythms. Whereas the circadian rhythm endogenous, there are other rhythmic changes on organisms caused by external agents, such as light and temperature variations, which are known as exogenous. The circadian clocks, as well as cells and all organisms, receive these exogenous signals, or inputs, and synchronize them, to which Rensing (1972) and Rensing, Meyer-Grahle, and Ruoff, (2001), following Jürgen Aschoff (1960), calls *zeitgeber*:

In the last decades, the intracellular pacemaker(s) that drives the numerous circadian rhythms is more commonly referred to as the *circadian clock* (1–3,100). This clock metaphor suggests that the oscillation has evolved to function as a clock (see definition and significance of clocks above). The functions of the circadian clock require that the clock mechanism can be reset (or synchronized) by means of external signals ("zeitgeber") and that it be able to produce internal signals to time the numerous driven processes ("hands"). Since circadian clocks act to synchronize organismic processes with the daily astrophysical changes, they also developed a mechanism that makes the clock rather independent of environmental temperature conditions (temperature compensation), although the molecular mechanisms of such compensations are still unclear (76,101,102). The clock mechanism has recently been unraveled, at least partly, in organisms as diverse as a cyanobacterium (*Synechococcus*) (103,104), a fungus (*Neurospora*) (4,105), an insect (*Drosophila*) (106), and a mammal (mouse) (107–109). (Rensing, Meyer-Grahle, & Ruoff 2001, pp. 341-42)

This process of induction and transduction gives us valuable data for the analysis of transfer, synchronization and transformation processes operated in digital artworks. Through exogenous signals, or *zeitgeber*, an organism converts and synchronizes its endogenous mechanisms. In this way, the concept of *zeitgeber* comprises a group of notions that are conducive to literary and artistic theoretical analysis.

b) The I/O (Input/Output) function. In physics and the control theory of mathematics and computer systems, any system, especially those mediated by a transducer, has a transfer function with regard to the control relationship between its input and output. As a summary, this is the elementary process of transduction already described in several disciplines.

c) The *author function*. On the philosophical and literary level, it is important to mention the author function, coined by Michel Foucault (1969 [1997]) as a function of textual discourses. The author function is part of the world of discursiveness and designates any legitimating, legal, institutional, cultural and literary system, which transfers, classifies and transforms the plurality of foundational subjects of discursivity, acting as a deviation from the traditional concept and weight of 'author' that has been conceived since Romanticism. Like the transducer function, the author function 'is not universally and constantly exercised on all discourses' (Foucault, 1997, p. 48), nor 'in all ages and in all forms of civilization' (ibid., p. 56).

Although the position advocated here does not directly derive from the chronobiological, mathematical or poststructuralist method, nor from any other methods already presented and developed in this essay, all the collected principles serve to characterize the transducer function as a recognizable system in the works of electronic literature and digital art.

3 | THE TRANSDUCER FUNCTION IN ELECTRONIC LITERATURE AND DIGITAL ART

What distinguishes one general domain from another? What distinguishes electronic literature from digital art? One could say that, for instance, a

net.art work or a playable environment with characteristics remarkably pictorial differs from a work whose main focus is narrative. One could get into a confrontation of definitions, by correctly mapping each division, according to our disciplinary strategic interest! However, what about a playable environment with pictorial features and a literary and narrative focus? Or what about a generative poem or fiction with visual and sound concerns? Or, from another perspective, what about a literary or artistic work crossing ludology?

Once again, critics define categories so that creators can transgress them. It does not matter to define a set of categories as a stamped seal, taking into account even more, the increasing intensity of the hybridization flow of literary and artistic genres since the 1960s.

Therefore, assuming these two domains in their distinguishing specificity, while at the same time recording the similarity and intersection of their themes and processes, it is necessary to create points of connection between electronic literature and digital art. This viewpoint allows us to dilute the boundaries between disciplines and genres, firstly benefiting the analysis of individual works and, secondly, the comparative analysis of works.

Categories are partially or fully diluted – that is no novelty within the artistic community, whether in literature or art; now, within the theoretical and academic community, this finding, combined with a desire to embrace and extend this phenomenon, has just recently been felt. In my opinion, one of the main efforts in this regard was Joan Campàs's "The Frontiers Between Digital Literature and Net.Art" (2004), published at the 'journal für digitale ästhetik' [1] *dichtung-digital*, founded by Roberto Simanowski in 1999. According to Campàs, the digital universe has catalyzed a gradual fading of disciplinary boundaries, given the fact that the creators use the same tools, e.g. software. In this sense, there is a cleavage and a shifting paradigm from the static to the dynamic image and the shared presence of the machine, opening the phenomena of simulation and interactivity. At the core of this change, generated by *techné,* there is a shared vision of the same system of coordinates for the creation and dissemination of visual and textual forms, using the same technology, enabling the dawn of an unprecedented moment in the history of mankind:

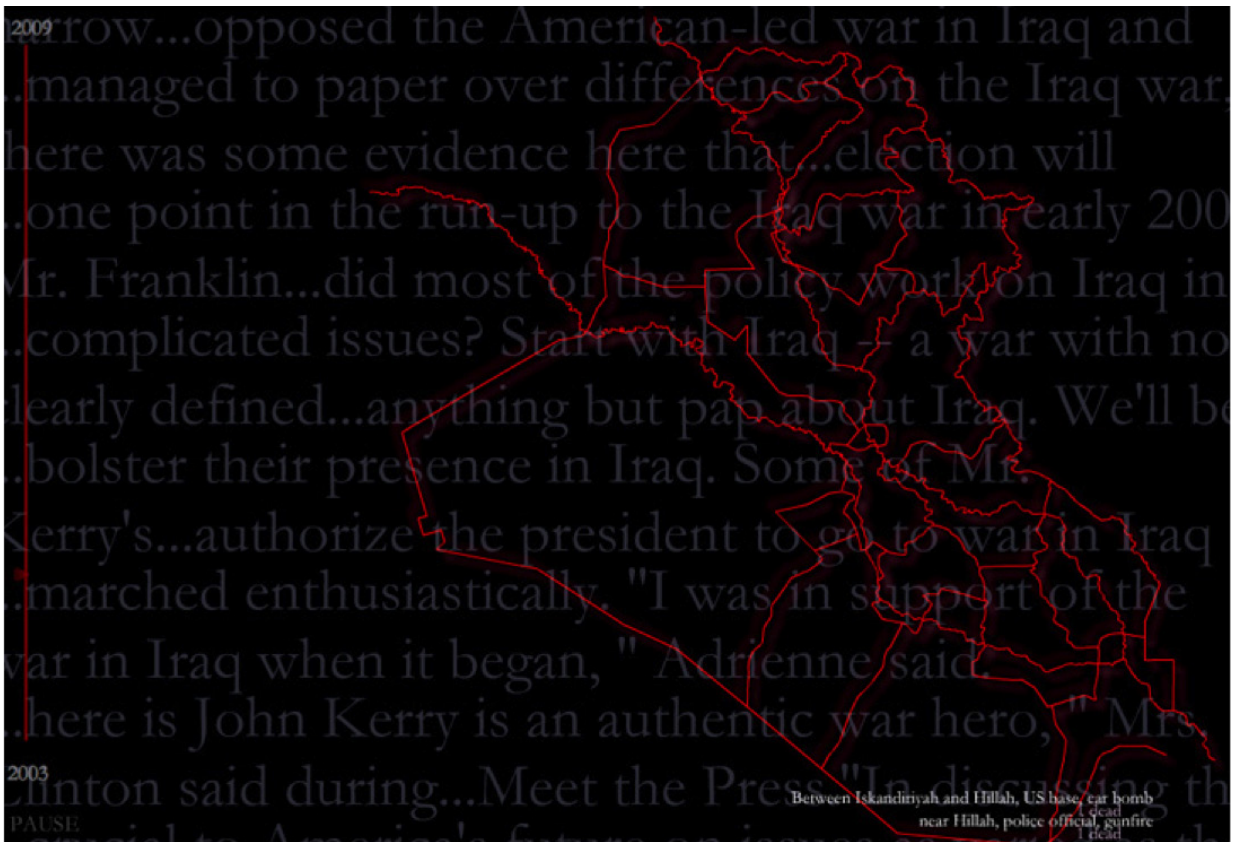

FIGURE 1 | R. Luke DuBois, *Hard Data* (2009). Online, open-source artwork. Computer loaded with kioskware, screen display, speakers. Courtesy R. Luke DuBois and bitforms gallery, New York.

These two characteristics – calculation and interactivity – configure the irrefutable technical novelty of the digital image and give it qualities that no image has ever had up to now. For the first time in the history of figurative techniques, the morphogenesis of texts and images (the creation of forms) and their distribution (diffusion, conservation, reproduction and socialization) depends on the same technology, which profoundly modifies the traditional status of text and image and has direct repercussions for the fields of literature and art. (Campàs, 2004)

Faced with such verification, I must applaud and rejoice since my understanding is based precisely on this assumption. Indeed, by simultaneously gathering and dealing with both fields from multiple flanks, one is able to discover the best input for the transducer function.

4 | CASE STUDIES

In my main essay "Transduction: Transfer Processes in Digital Literature and Art" (Seiça, 2011), I applied the transducer function as a reading typology to several works, such as Mark Z. Danielewski's *House of Leaves* (2000); Stuart Moulthrop's *Victory Garden* (1991); R. Luke DuBois's *Billboard* (2006), *Hindsight is Always 20/20* (2008), SSB (2008), *Hard Data* (2009), *Kiss* (2010) and *A More Perfect Union* (2011); and to André Sier's k. *series* (2007-2011), CsO (2008), *Non-Newtonian* (2011), *32-bit Wind Machine* (2011) and *32-bit Difference Machine* (2011).

In the critical approach to these works, certain media, themes, mechanisms, languages and common grounds became explicit: authorship, user, cybertext, surface, hypertext, infoduct, interactivity, pixel, algorithm, code, programming, network, software and data. Part of that survey, "Anti-Spam: Reinventing Data" (Seiça, 2012), considers the way data is collected, transferred, converted and recreated nowadays by artists.

Four artworks analyzed within the scope of data mining and data visualization were R. Luke DuBois's *Hard Data* (2009) and *A More Perfect Union* (2011), and André Sier's *CsO* (2008) and *32-bit Wind Machine* (2011).

DuBois's *Hard Data* (Figure 1), a Flash net.art work, transforms statistical data (2003-2009) from USA's military invasion of Iraq into a new virtual environment where text, image and sound overlap, creating a disturbing perspective on war. More recently, with *A More Perfect Union* (Figures 2 and 3), a transmedia work, DuBois managed to gather the online dating profiles of more than 19 million single Americans in order to reinvent a possible American census that reacts according to emotional states, that is, self-attributed adjectives that form keywords. These keywords were afterwards applied on national maps, according to female or male usage, and state and city maps, according to their recurrence in a city and town. The result is an overwhelming visualization that shows how effective, socially remarkable and aesthetically interesting a conversion of data can become.

Sier's video *CsO* (Figure 4), or *BwO* (Body without Organs), does also generate a new visualization of textual data, in this case, the full-length text of Deleuze & Guattari's "Comment se faire un Corps sans Organes" (1980). The video speeds up human reading on a cybernetic level, recreating a new 3D dataspace that highlights the interval between words and the gap triggered between human reading and machine execution. On the other hand, *32-bit Wind Machine* (Figure 5), a digital installation,

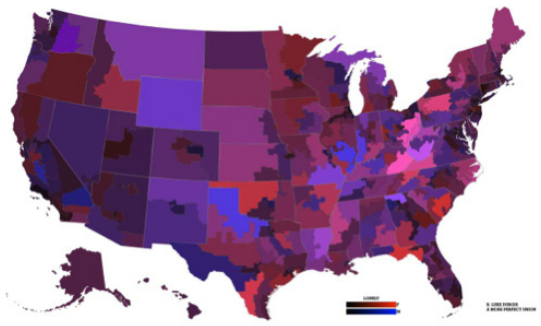

FIGURE 2 | R. Luke DuBois, *A More Perfect Union: Lonely* (2011). Pigment-ink on photo rag. 18 x 24"/ 46 x 61 cm. Courtesy R. Luke DuBois and bitforms gallery, New York.

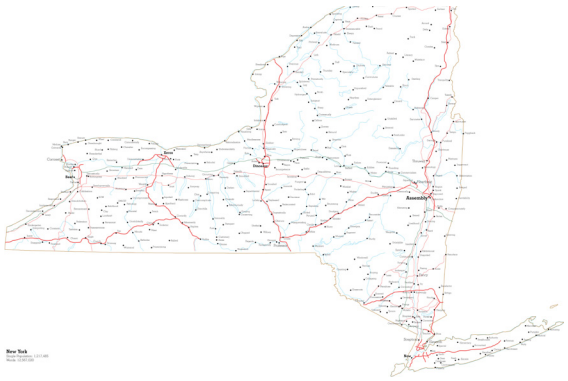

FIGURE 3 | R. Luke DuBois, *A More Perfect Union, New York State* (2011). Pigment-ink on photo rag. 24x36"/61 x 91.5 cm. Courtesy R. Luke DuBois and bitforms gallery, New York.

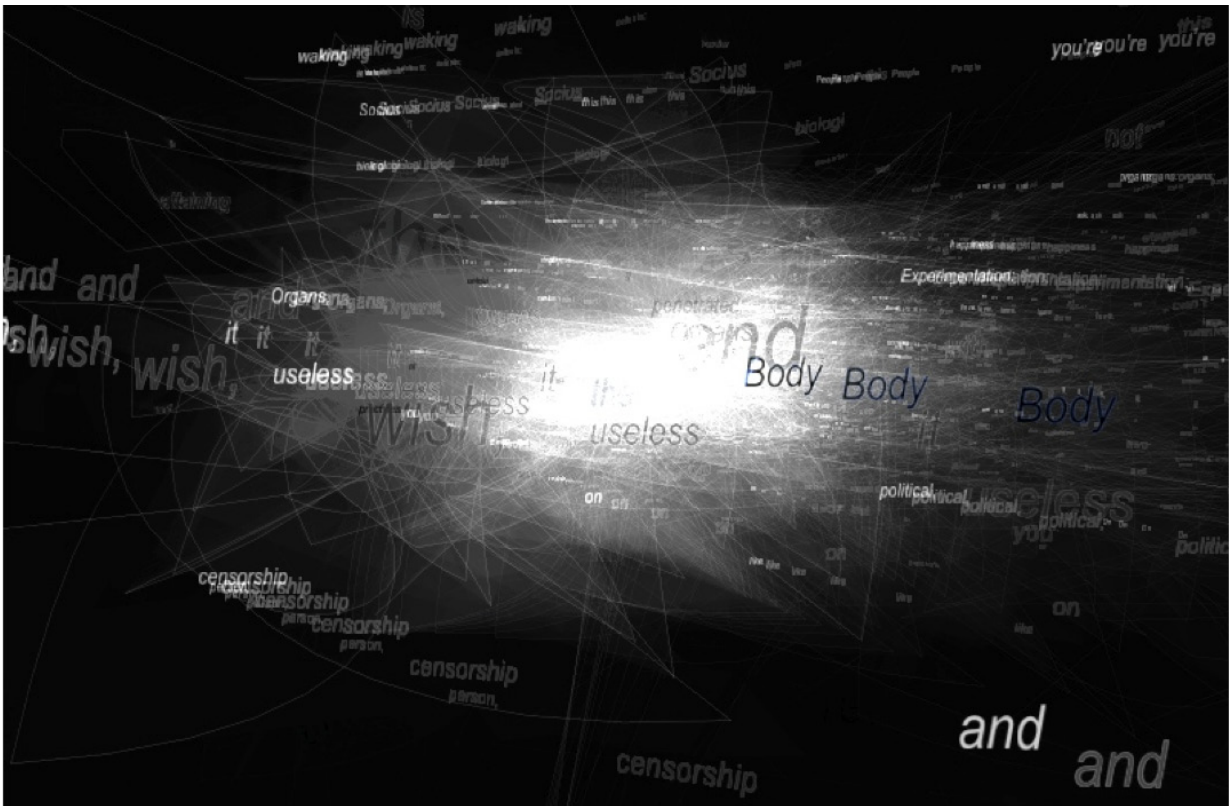

FIGURE 4 | André Sier, *CsO* (2008). Code + HD video, colour, 1 min. + 2:43 h. Courtesy André Sier.

uses real-time site-specific data from the wind in order to convert it into a game between machine and nature, which recalls the *zeitgeber* function of an organism. This real-time arithmetic game creates a new visualization that can be simply seen as an aesthetic result but, otherwise, if taken more deeply, as a black hole that collapses and resets the machine each time the operations reach a limit. Whether one could be experiencing these digital artworks, or reading electronic literature works, one perceives a constant and recurrent assemblage, transfer and transformation of a certain kind of raw data into a creative one. Scott Rettberg's *Frequency Poems* (2009), a set of digital kinetic poems created with a poetry generator, is a fine example of this paradigm. In these dynamic poems (Figure 6), the authorship is attributed to both Scott Rettberg and the machine, which settles the built-in environment for an interaction and readjustment between writer and machine, afterwards experienced by the reader through the programmed source code and its converted visualization.

By using only two hundred of the most common English words selected from Web tags, Rettberg wrote a program with two thousand possible lines, which in turn the machine manipulates, generating new rearranged poems that are constrained by syllable count, character count, and rhyme scheme.

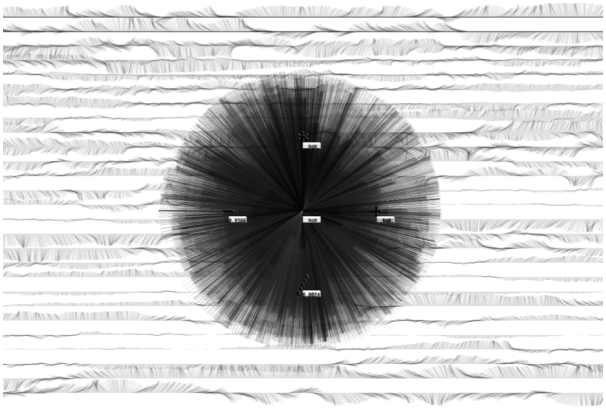

FIGURE 5 | André Sier, *32-bit Wind Machine* (2011). Computer, projector, wind sensor. Courtesy André Sier.

By selecting a fixed number of words and a fixed number of old and new rhyme schemes in order to compose his poems, Rettberg accomplishes a maximization of his poetic production, as the creators of OuLiPo did. There are several poetic constraints applied to the programmed parameters: the maintenance of certain frequencies, or traditional poetic typologies, such

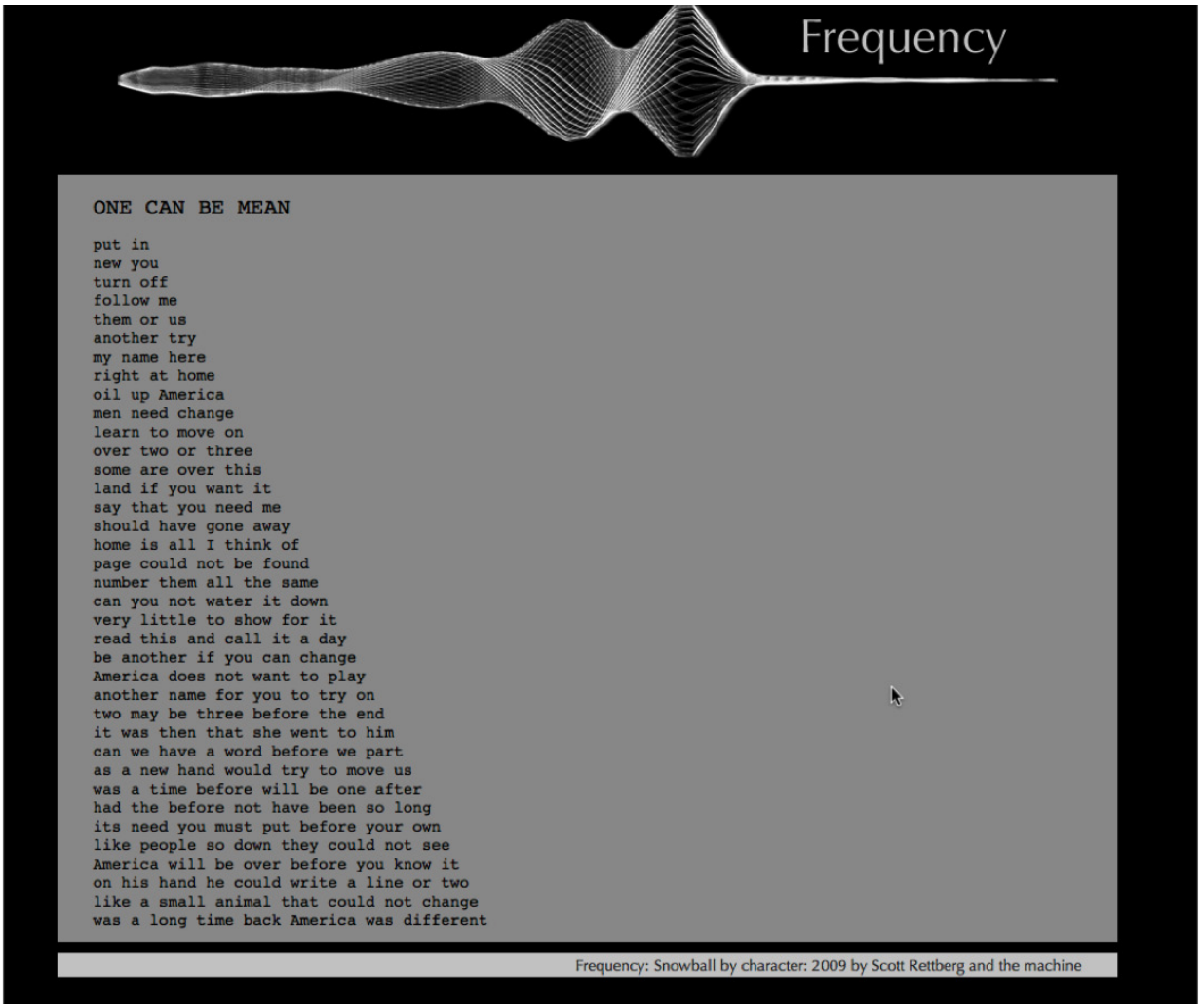

FIGURE 6 | Scott Rettberg, *Frequency Poems* (2009). Online, open-source artwork (Detail: "One Can Be Mean". Frequency: Snowball by character). Code, computer and screen display. Courtesy Scott Rettberg.

as the Petrarchan, the Spenserian and the Shakespearean rhyme schemes, the *haiku* or the OuLiPian snowball, amongst others, which make us think that this could be the classical poetry machine envisioned by Italo Calvino: the traditional poetry generator. However, the flexibility of the combinations, the new poetic typologies created by Rettberg, intertwining form/content, image/word, and the source material, bring us to a different conclusion: the construction of poetic language, even aided by the programming language Ruby, takes place without the use of a vocabulary commonly associated with poetry, but rather with the vocabulary of everyday life. The fact that the source material sprang from the most common English words represents an entropic analysis on the "state of the art" of American life style. On the one hand, this point of view regarding a nation, dealing with its more basic values and expressed by the more *frequent* words, somehow shows a trivialization of language itself, a lack of the *sublime* developed by mass media and the contemporary world. On the other hand, a critical position about the obligation of that same *sublime* in poetry may also state that the creative act can stem from frequency: from the banal.

5 | CONCLUSION

Underlying this essay, I took into special consideration the principle of transfer and conversion between data and media, as many writers and artists have recently put their emphasis on working with data of a certain nature to subsequently transform and recreate it. In this sense, the concept of transducer has proven to be relevant when intersected with the fields of literary and artistic studies, specifically the theory of electronic literature and digital art, since one of the basic

devices of the virtual environment is the file, with its consequent specification of storage, transfer and data con-version. A file always transforms a certain type of data into another (e.g. converting code into sound).

Hence, I developed the transducer function as a set of transfer and conversion processes of various patterns, given its recurrence in several artworks, thus constituting a critical substrate for my approach.

As it seems to me, the transducer function is present in several works of electronic literature and digital art. As an introduction to a theoretical typology, I hope this essay opens up the doors for its validation, allowing us to deduce that it is effective, resistant and responds not only to different works in different genres, but also to future works, expan-ding the analyses of literary and artistic production in the context of digital culture.

ENDNOTES

[1] The forty-one issues of *dichtung-digital* and the quality of its essays testify its importance and influence. The journal can be accessed at http://dichtung-digital.de.

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BIOGRAPHICAL INFORMATION

Álvaro Seiça (1983, Aveiro, Portugal) is a writer, researcher, editor and curator. He holds a MA in Contemporary American Literature, having received a *summa cum laude* for his thesis "Transduction: Transfer Processes in Digital Literature and Art". In 2007, with Gaëlle Marques, he founded BYPASS (http://bypass.pt), a nomadic editorial and curatorial project. He has published several poems and essays on different journals, the most recent being "Anti-Spam: Reinventing Data" (2012), at *Parsons Journal for Information Mapping*, PIIM/New School, New York. He currently lives in Malmö, Sweden.